Another looks to the reclamation of a still larger tract lying between Boise and Mountainhome, with water stored at the head of the Salmon River and brought under the Sawtooth Mountains in a tunnel.

The United States Reclamation Service is making extensive surveys and test borings for reservoir sites in the Boise watershed to augment the water supply for the Payette-Boise project.

The question of drainage of irrigated lands is engaging the attention of engineers in southern Idaho. The United States Reclamation Service is constructing a drainage system for the North Side Minidoka Project, near Rupert, and steps are being taken to attend to the matter of drainage in the Pioneer Irrigation District. In close connection with this is the problem of water conservation. Mr. Don H. Bark, of the United States Department of Agriculture, is conducting an elaborate system of experiments looking to a more economical use of water.

Several small power plants are being constructed on the Payette River in Long Valley. One of these, at Tamarack Falls, will supply power to the town of Roseberry, and another at Van Wyck Falls will furnish power for Van Wyck, Crawford, and Thunder City.

REPORT ON THE ANNUAL RISE IN THE COLUMBIA RIVER, 1910.

By T. F. DRAKE, Assistant Observer, Portland, Oreg.

There are two principal causes that operate to produce the annual spring rise in the Columbia River: The accumulated depth of the winter's snow in the mountains and foothills at the close of the cold season, and the effect of the subsequent temperatures upon the melting of this snow. An abundance of snow in the higher levels at the end of winter, and an early spring with steady warm or mild weather, will obviously cause an earlier annual rise of approximately shorter duration, and higher river stages than usual, while, under similar snowfall conditions, if the temperatures of spring are divided into periods of alternately warm and cool spells, it is evident that the annual rise will extend through a longer period of time and the maximum stages reached will not be so great.

TABLE 1.—*Monthly and seasonal snowfall at selected stations.*

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Seasonal.
Montana.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Bison Mountain	21.7	35.2	19.0	73.5	12.0	6.0	188.2
Fortine	2.5	16.0	14.8	22.0	2.0	T.	57.3
Hat Creek	10.3	17.9	9.6	29.9	2.3	4.5	83.7
Kalispell	4.1	9.1	8.8	19.1	4.1	2.1	47.3
Ophir	9.0	10.0	0.5	8.5	1.0	4.0	41.5
Philipsburg	6.3	4.3	9.5	24.7	T.	2.0	49.8
Saint Ignatius	2.0	6.2	4.2	20.6	T.	0.5	33.7
Saint Regis	3.6	3.3	11.4	38.7	0.0	0.0	57.0
Saltese	3.0	21.0	50.0	72.5	14.0	5.0	165.5
Idaho.							
Blackfoot Dam	14.4	17.5	24.0	25.0	6.0	1.0	87.9
Burke	19.5	23.0	58.5	89.0	13.0	9.5	212.5
Loon Creek	8.0	14.0	22.1	25.3	4.5	0.5	74.4
Edie	10.0	9.0	21.0	40.0	0.0	4.0	84.0
McCall	11.2	30.5	30.0	23.0	3.0	0.0	97.7
Silver City	17.4	26.5	15.9	30.1	1.2	T.	91.1
Pine	5.0	40.0	48.6	24.0	0.0	.....	117.6
Pyle Creek	6.9	32.3	61.5	48.8	0.0	T.	149.5
Average	9.1	18.6	24.1	36.2	3.7	2.4	93.4

Reports received early in April from Weather Bureau sources indicated that the snowfall at the headwaters of the Snake River, in Idaho and Wyoming, and at the headwaters of the branches of the Columbia in Montana during the winter had been heavier than usual, while reports from the Canadian Meteorological Service showed less than the usual amount for the winter over the Columbia River watershed in British Columbia. The accompanying table shows the snowfall conditions that obtained at selected stations in Montana and Idaho during the principal snowfall months. The comparatively heavy snowfall of December, January, and February especially, is here shown, and it will be noted that the accumulated snow on the ground at the end of February was only about 6 inches less than the total snowfall for that month. A study of Tables 1 and 2, in connection with Table 3, will be very interesting, since the chief conditions affecting the river stages are indicated in the tables in a manner that permits of their being readily seen and appreciated. It should, however, be borne in mind that the figures given for the depth of the snow blanket at the end of March, and also at the end of April, do not represent the amount of snow gathered in drifts in the canyons and ravines in the higher levels; otherwise it might be difficult to explain satisfactorily why the highest river stages occurred this year in May. It may be mentioned that snow fell in some localities as late as May in considerable quantities.

TABLE 2.—*Accumulated depth of snow on ground at end of month.*

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Montana.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches*
Bison Mountain	6.0	27.0	20.0	48.0	12.0	0.0
Fortine	0.0	5.0	T.	4.0	0.0	0.0
Hat Creek	0.4	12.5	7.0	18.0	0.0	.....
Kalispell	0.0	2.2	0.0	6.3	0.0	0.0
Ophir*						
Philipsburg	0.0	2.5	2.0	10.0	0.0	0.0
Saint Ignatius	0.0	0.0	0.0	3.0	0.0	0.0
Saint Regis	.....	0.5	10.0	8.5	0.0	0.0
Saltese	0.0	14.0	30.0	68.0	24.0	0.0
Idaho.						
Blackfoot Dam	6.8	23.0	24.0	34.0	5.0	0.0
Burke	0.0	15.0	39.0	76.0	5.0	0.0
Loon Creek	4.0	13.0	18.5	31.0	0.5	0.0
Edie	5.0	9.0	30.0	16.0	0.0	0.0
McCall	T.	29.0	36.0	55.0	24.0	0.0
Silver City	0.0	2.0	11.8	30.0	0.0	0.0
Pine	0.0	25.0	34.0	36.0	0.0	.....
Pyle Creek	0.0	17.5	31.0	40.0	0.0	0.0
Average	1.5	12.3	18.3	30.2	4.4	0.0

* No record.

In all sections the weather during March was comparatively mild, the temperatures being uniformly above normal, and much of the snow in the higher levels melted, while at low and moderate elevations the snow generally had all disappeared by the end of the month. The snow remaining in the mountains at the close of the month was well packed and in a favorable condition for slow melting and a gradual run-off later. The heavy rains of February and early March, combined with the abnormally warm weather of the latter month, resulted in unusually high water in all streams, and flood conditions obtained in many sections. As a consequence there was much apprehension among interested people, particularly wholesale firms located in the lower sections of Portland, farmers engaged in cultivating the lowlands along the lower Columbia, fishermen, and logging and lumber companies operating along the lower course of this river or its tributaries, fears being entertained that these earlier floods were indicative of a greater annual rise that probably would equal, if not exceed, the highest stages recorded. These fears were, however, partially allayed by our reports to the effect that much of the snow was already melted, while that remaining in canyons and ravines, and at high elevations, was favorably conditioned for melting slowly, consequently resulting in a gradual run-off.

Table 3 shows the temperature and precipitation conditions that obtained in those sections whose weather most strongly influences the volume of water in the Snake and the upper Columbia rivers, and hence contributes most to the variable stages of the lower Columbia.

TABLE 3.—*Temperature and precipitation of the northern Plateau and northern Rocky Mountain region, winter of 1909–10.*

Year and month.	Temperature.		Precipitation.	
	Mean.	Departure.	Average.	Departure.
1909.	° *F.*	° *F.*	*Inches.*	*Inches.*
November	40.4	+3.3	2.72	+0.14
December	23.3	−6.8	1.24	−0.04
1910.				
January	25.3	−1.6	1.36	+0.02
February	25.5	−4.6	1.63	+0.61
March	46.9	+8.4	0.99	−0.04
Mean	32.2	−0.3	1.59	+0.02

As will be seen by the above table, the precipitation over the section under discussion was considerably above the average for November, but the weather was abnormally warm and a greater portion than usual of the precipitation fell as rain, and it was instrumental in increasing the volume of water in the Snake and the Columbia rivers above the monthly average. The November snowfall contributed but little to the winter's accumulated depth, but in January and February, with more than the usual amount of snowfall and temperatures below the normal, the snow depth increased probably beyond the usual amount. Spring opened earlier than usual, and March with temperatures much above the normal, caused, as already mentioned, the snow in exposed places to melt rapidly, resulting in high water in all streams during that month, and causing apprehension for an unusual volume of water in the Columbia during the annual rise.

April was exceptionally warm, and the mountain snows continued to melt rapidly; and as will be seen by the accompanying hydrograph, the Columbia and the Snake rivers began to rise in their lower courses about the 7th and continued to rise without any marked interruption until the end of the month. The flood stage, however, was not reached at any of the gaging stations, although at Vancouver, Wash., the gage registered only 0.1 foot short of the flood stage, and at Portland, on the Willamette, backwater from the Columbia caused a stage of 16.3 feet, which is 1.3 foot above the flood stage. Backwater affects the stage of the Willamette at Portland to such an extent that there is a marked similarity in comparative stages of the two rivers at Vancouver and Portland, respectively; hence the flood crests at Portland, as given in Table 4, show quite accurately the stages of the lower Columbia throughout its course.

TABLE 4.—*Flood crests at Portland, Oreg., during annual rise of Columbia River.*

Year.	Stage.	Year.	Stage.	Year.	Stage.	Year.	Stage.
1879	19.3	1887	25.7	1895	16.3	1903	24.0
1880	27.3	1888	18.2	1896	23.8	1904	20.8
1881	19.7	1889	10.0	1897	23.7	1905	13.6
1882	26.1	1890	20.1	1898	20.7	1906	13.4
1883	17.8	1891	14.1	1899	24.2	1907	19.2
1884	20.2	1892	19.3	1900	17.8	1908	21.2
1885	14.5	1893	22.0	1901	20.8	1909	21.4
1886	20.0	1894	33.0	1902	20.7	1910	19.1

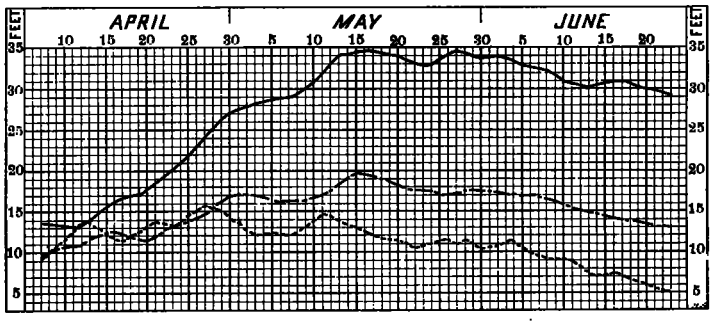

FIG. 1.—Hydrograph showing successive stages of the Columbia and Snake rivers at three representative stations in District No. 12.
———— Wenatchee, Wash., Columbia River.
– – – – – – Vancouver, Wash., Columbia River.
. . . . . Lewiston, Idaho, Snake River.

The highest stages along the Snake River were reached during the last 3 days of April, but there was a secondary rise during the first half of May, which increased the stages along the lower Columbia, and the highest stages along the Columbia River were generally recorded on May 14 to 16. The following table shows the highest recorded stages, with dates of occurrence at all stations on the Snake and Columbia rivers.

River navigation was not materially interfered with during the rise, except from May 12 to 18, inclusive, when the highest stages were recorded along the lower Columbia. At this time the current was so strong at Cascade Locks that boats, full-freighted, could not ascend the river, and were compelled to return to Portland and discharge a portion of their cargoes before passing the locks. The locks close at a stage of 34 feet, as registered at The Dalles, and a stage of 31 feet at the last-named point gives a current too strong for boats of the present type to overcome; more powerful boats would, however, have experienced no difficulty in making regular trips during this time. Navigation on the Snake River is never impeded by high water.

TABLE 5.—*Annual rise Columbia River, 1910, highest water and dates of occurrence.*

Stations.	Height	Date.	Stations.	Height	Date.
Weiser	10.5	April 28, 29, 30.	Kennewick	16.5	May 14.
Lewiston	15.6	April 27.	Umatilla	19.9	May 14.
Riparia	14.8	April 28.	Celilo	16.3	May 14.
Bonners Ferry	24.4	May 12.	The Dalles	33.1	May 14.
Newport	15.7	May 16, 17, 18.	Cascade Locks	25.9	May 15.
Northport	22.9	May 29, 30.	Vancouver	19.6	May 15, 16.
Wenatchee	34.8	May 16, 27.	Portland	19.1	May 15, 16.

Throughout the rise the stages of the river at Portland were quite accurately foretold, and, acting on this timely information, perishable goods were removed to places of safety, and other precautionary measures were taken to minimize the danger as far as the interests affected were concerned. As no reported damage occurred, it is obvious that the warnings have been of great value in protecting property interests. At Portland the river was above the flood stage from April 28 to June 10, a period of 43 days, and at highest water was 4.1 feet above that stage.

FROST FIGHTING IN THE BOISE VALLEY.

By EDWARD L. WELLS, Section Director

The spring of 1910 was a favorable one for the fruit growers in the Boise Valley, and an unfavorable one for making experiments in protecting crops from frost. There was but one serious frost, and partly because of extensive use of orchard heaters, and partly because of the fact that this frost came so early (April 15) that the buds and blossoms of commercial fruits had not yet reached the most tender stage, little damage resulted.

For the first time in the history of the valley, oil heaters were used by fruit growers. They were purchased in car lots, as was also the fuel oil for use in them. The Weather Bureau was in constant touch with the growers, rendering valuable assistance in critical times, but could have been of much greater assistance had the growers themselves been better organized. The office was kept open all night on 11 nights, and part of the night on a number of others. The plan was to keep open whenever there was any cause for uneasiness, and this plan saved the growers much time and energy in watching, and a considerable amount of material.

On the night of April 14–15, Mr. Arthur W. Garrett, formerly an assistant observer in the Weather Bureau, and now manager of the Garret Mercantile Company, at Meridian, 10 miles west of Boise, spent the night in the orchard of Mr. W. N. Yost. He has kindly furnished this office with a report of his observations, extracts from which are given below:

The first observation of temperature, at 12:30 a. m., showed a reading of 28°. Several observations were taken between 12:30 and 2:30, the temperature fluctuating considerably, probably due to changes in the direction of the wind. The readings varied from 26° to 31°. While the wind shifted considerably during the night, it was generally from a westerly direction during the fore part of the night, and from an easterly direction during the latter part. There was a noticeable breeze at times, but toward morning it was generally quiet.

At 2:30 a. m. the lighting of the pots was commenced, at which time the temperature in the orchard stood at 26°. At first only about half the pots were lighted, the lids being pulled back about one-third. Several observa-